ARMAMENT LABORATORIES
ELECTRONICS SECTION
ATT. OML-22

J+M 169

NO. 8662
PORTABLE PRECISION POTENTIOMETER

DIRECTION
BOOK
77-29-0-2

LEEDS & NORTHRUP COMPANY
4901 Stenton Avenue
Philadelphia 44, Pa.

ARMAMENT LABORATORIES
ELECTRONICS SECTION
ATT. OML-22

CONTENTS

Section		Page
1.	General Data	4
2.	Connections	4
3.	Focus Index On The Scale	6
4.	Adjust Galvanometer Zero	7
5.	Adjust Current In Potentiometer Circuit	7
6.	Set Reference Junction Compensator	8
7.	Measure EMF	9
	A. High Range	10
	B. Low Range	10
8.	Readings	11
	A. High Range	11
	B. Low Range	11
9.	Standard Cell Data	11
10.	To Check Standard Cells	12
11.	Dry Cells	12
12.	Checking Potentiometer Recorders, Controllers, And Indicators	13
13.	Galvanometer	15

77-29-0-2 10-452 Litho. in U.S.A.

NO. 8662

PORTABLE PRECISION POTENTIOMETER

1. GENERAL DATA

The directions contained herein apply only to No. 8662 Potentiometers with serial number 371500 or higher. Refer to separate directions for other No. 8662 Potentiometers.

CAUTION: This instrument is shipped from the factory with a bar connected across the GA terminals to short circuit the galvanometer. For normal operation of the potentiometer, this bar must be removed from the GA terminals or at least disconnected from one terminal and swung out far enough to remove the short circuit from the galvanometer. The bar should be used across the GA terminals as indicated in Section 12.

The No. 8662 Potentiometer is designed primarily for measurement of thermocouple emf but can be used to check other potentiometer type instruments, as outlined in Section 12, and incorporates a means of manually compensating for reference junction emf.

The instrument has two ranges, one of 0 to 16 millivolts and one of 0 to 80 millivolts. The reference junction compensating dial also has two ranges, one of 0 to 1 millivolt and one of 0 to 5 millivolts.

Three No. 6 dry cells are furnished installed in a compartment in the right hand end of the instrument. Two of these dry cells are connected in series to supply current to the galvanometer lamp. The other dry cell is connected to supply the potentiometer current.

2. CONNECTIONS (Fig. 1)

Connect the thermocouple whose emf is to be measured to the E.M.F. posts with polarity as indicated at these posts. The following table gives the polarity of the commonly used thermocouples. If it is desirable to bring the reference junction to the E.M.F. posts, use extension leadwires listed in the table.

NOTE: When using a potentiometer, which is equipped with a manually operated reference junction compensator (such as the No. 8662 Potentiometer), for measuring sub-zero temperatures (temperatures below 0 C or 0 F), the leads from the thermocouple to the potentiometer should be connected to the proper terminals on the potentiometer with polarities reversed from normal. In other words, connect the positive lead to the negative terminal and the negative lead to the position terminal. For measurements refer to Section 7 B.

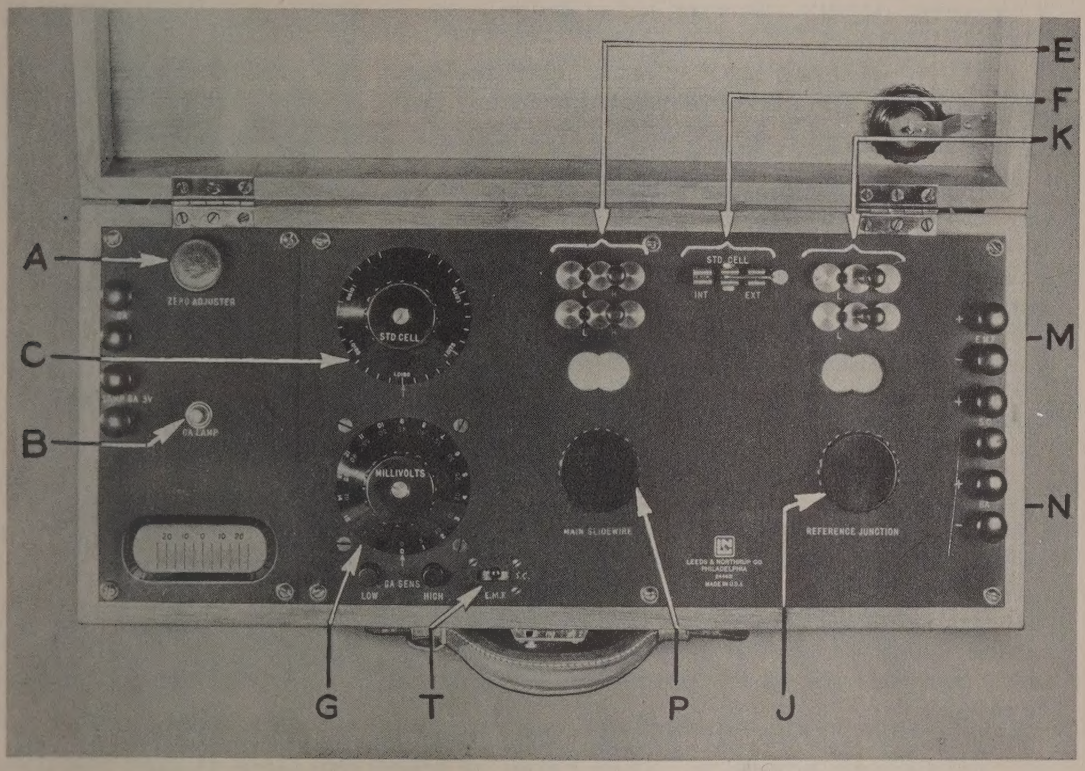

Fig. 1

No further connections need be made to operate the instrument when the dry cells and galvanometer contained in the instrument are used. It is possible, however, to use external dry cells (or batteries) and an external galvanometer.

LEADWIRE TABLE			
THERMOCOUPLE		EXTENSION LEADWIRE	
+	-	+	-
Iron	Constantan	Iron-white	Constantan-red
Copper	Constantan	Copper-white	Constantan-red
Chromel	Alumel-Slightly Magnetic	Chromel-yellow	Alumel-red
		Copper-white	Constantan-red
		Iron-yellow	Cupronel-red
Plat. Rhod.	Platinum	Black insulation	Red insulation

To use external dry cells, make connections as directed in Section 11.

To use an external galvanometer, make connections as directed in Section 13.

The internal connections are shown in schematic form in Fig. 4.

3. FOCUS INDEX ON THE SCALE (Fig. 2)

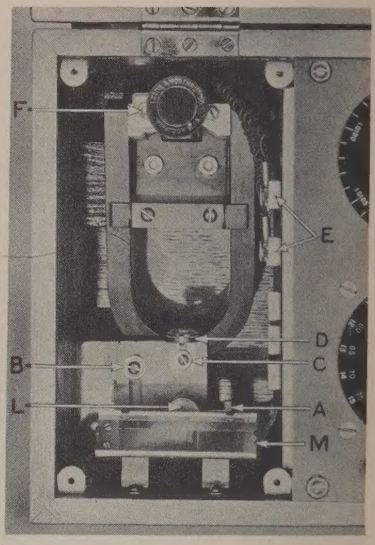

Fig. 2

(1) Remove the four screws from the top plate of the galvanometer compartment and lift off the plate.

(2) If the internal battery is used to supply the current to the galvanometer lamp, light the lamp by short circuiting the terminals stamped 1 and 2. If the lamp current is supplied from an external source, disconnect the external leads from the LAMP BA 3V posts and connect these leads to the terminals stamped 2 and 3. Turn the guard over the lamp with the opening toward the galvanometer.

(3) Check the position of the lamp, lens, and galvanometer mirror to determine if they are all in the same vertical plane passing through the center of the compartment. If this condition does not exist, loosen screw B and turn the support for the lamp and index until the lamp and mirror are in line. Tighten screw B and loosen screw C. Then turn the lens support until the lens is in the same plane with the mirror and lamp. Tighten screw C.

(4) Loosen screw A. Then raise or lower the lamp L until the light beam shows in the galvanometer mirror. Tighten screw A.

(5) Loosen screw B. Slide the support for the lamp and index forward or backward or turn slightly until the image of the lamp filament is focused on the galvanometer mirror. This adjustment can be simplified by placing a piece of clean white paper in front of the mirror and observing the image on the paper first. Then remove the paper and make the final adjustment. Tighten screw B.

(6) Loosen nut F. Adjust the position of the galvanometer system until the light spot from the galvanometer mirror appears (approximately in the center) on the scale mirror M. Tighten nut F.

(7) Replace the top plate (approximately in position) on the galvanometer compartment and note the image of the index (cross-hair) on the scale.

(8) If this image is not well defined, remove the top plate and loosen screw C. Move the index and lens D forward or backward until a well defined image of the index (cross-hair) appears on the scale, temporarily replacing the top plate for each check. Then tighten screw C.

(9) Remove the temporary connections from the terminals 1, 2, and 3.

Replace the top plate of the compartment, being careful to fit the slot in the zero adjuster on the rod attached to the galvanometer system. Reconnect the dry cells or battery for the permanent arrangement.

(10) If the image of the cross-hair is not parallel to the scale graduations, remove the top plate and rotate the index D in the holder until the image of the cross-hair is parallel to the scale graduations.

4. ADJUST GALVANOMETER ZERO (Fig. 1)

Pull out the plunger B to light the galvanometer lamp and then adjust the galvanometer zero by means of cap A until the image of the index (cross-hair) is at zero on the scale. Do not press either key LOW or key HIGH when making this adjustment.

5. ADJUST CURRENT IN POTENTIOMETER CIRCUIT (Fig. 1)

If the standard cell contained in this instrument is used, throw the standard cell knife switch F to the INT. position and set dial C to the standard cell voltage as given in Section 9. If an external standard cell is used, set switch F to position EXT., connect the standard cell to posts marked S.C., polarities as indicated at the posts, and set dial C to the certified voltage of the standard cell used.

When adjusting the potentiometer current, the plugs E and K may be in either the H or L position, as the position of these plugs will not affect the adjustment. Push the plugs in firmly with a slight twisting motion to assure good contact. Snap switch T to the S.C. position. Insert the detachable knob in dial M and turn it in a clockwise direction as far as it will go. Remove the detachable knob from dial M and insert it in dial N. Turn dial N in a clockwise direction as far as it will go. Tap key LOW and note the direction of the galvanometer deflection. Turn dial N in a counterclockwise direction as far as it will go. Tap key LOW. If the galvanometer deflection has reversed direction, adjust dial N, tapping key HIGH until there is no deflection of the galvanometer with the key HIGH open or closed. If, after turning dial N to the limit of its travel in a counterclockwise direction and tapping key LOW, the galvanometer deflection is in the same direction as before, remove the detachable knob from dial N and insert it in dial M. Turn dial M in a counterclockwise direction, tapping key LOW, until there is only a very slow and small galvanometer deflection in an opposite direction to that at first noted. Remove the detachable knob from dial M using care that the adjustment of dial M is not disturbed. Place the knob in dial N and adjust dial N, tapping key HIGH until there is no galvanometer deflection with key HIGH open or closed. Do not disturb the setting of the dials M and N until it is again necessary to adjust the potentiometer current.

Changing plugs E or K from the H to L position, or vice versa, does not change the potentiometer current.

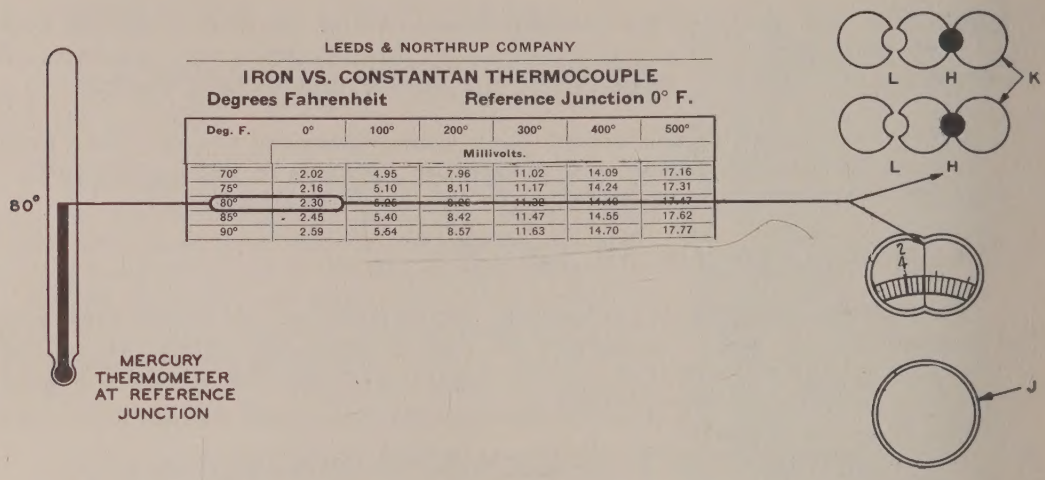
LEEDS & NORTHRUP COMPANY
IRON VS. CONSTANTAN THERMOCOUPLE
Degrees Fahrenheit Reference Junction 0° F.
Deg. F. | 0° | 100° | 200° | 300° | 400° | 500°
Millivolts.
70° | 2.02 | 4.95 | 7.96 | 11.02 | 14.09 | 17.16
75° | 2.16 | 5.10 | 8.11 | 11.17 | 14.24 | 17.31
80° | 2.30 | 5.25 | 8.26 | 11.32 | 14.40 | 17.47
85° | 2.45 | 5.40 | 8.42 | 11.47 | 14.55 | 17.62
90° | 2.59 | 5.54 | 8.57 | 11.63 | 14.70 | 17.77
80°
MERCURY THERMOMETER AT REFERENCE JUNCTION
L
H
K
L
H
J

Fig. 3

When the dials M and N have reached the limit of their travel in a clockwise direction and the galvanometer cannot be balanced, the dry cell or battery must be renewed.

When using a new dry cell or a new battery, the potentiometer current should be adjusted at frequent intervals during the first day in service owing to changes in voltage during the first few hours of service.

6. SET REFERENCE JUNCTION COMPENSATOR (Fig. 3)

Read the reference junction temperature on a mercury thermometer having a limit of error of 1/4 F, consult temperature vs. millivolt tables to determine the corresponding reference junction emf. If the reference junction emf is below 1 millivolt, place the plugs K in the L position and set the value of the reference junction emf on the black numbered scale of the reference junction slidewire J under the hair-line index. If the reference junction is between 1 and 5 millivolts, place the plugs K in the H position and set the value of the reference junction emf on the red numbered scale of the reference junction slidewire J, under the hair-line index. Changing the plugs K from H to L does not change the potentiometer current; therefore, another current adjustment is not necessary.

When using two or more thermocouples connected in series, set the reference junction compensator as follows: Determine the temperature of the reference junction by using a thermometer as indicated in the preceding paragraph and, from the proper conversion table, determine the millivolts corresponding to this temperature in the usual manner. Then multiply this millivolt value by the number of thermocouples connected in series and set plugs K and dial J at the positions which correspond to the product of these two quantities.

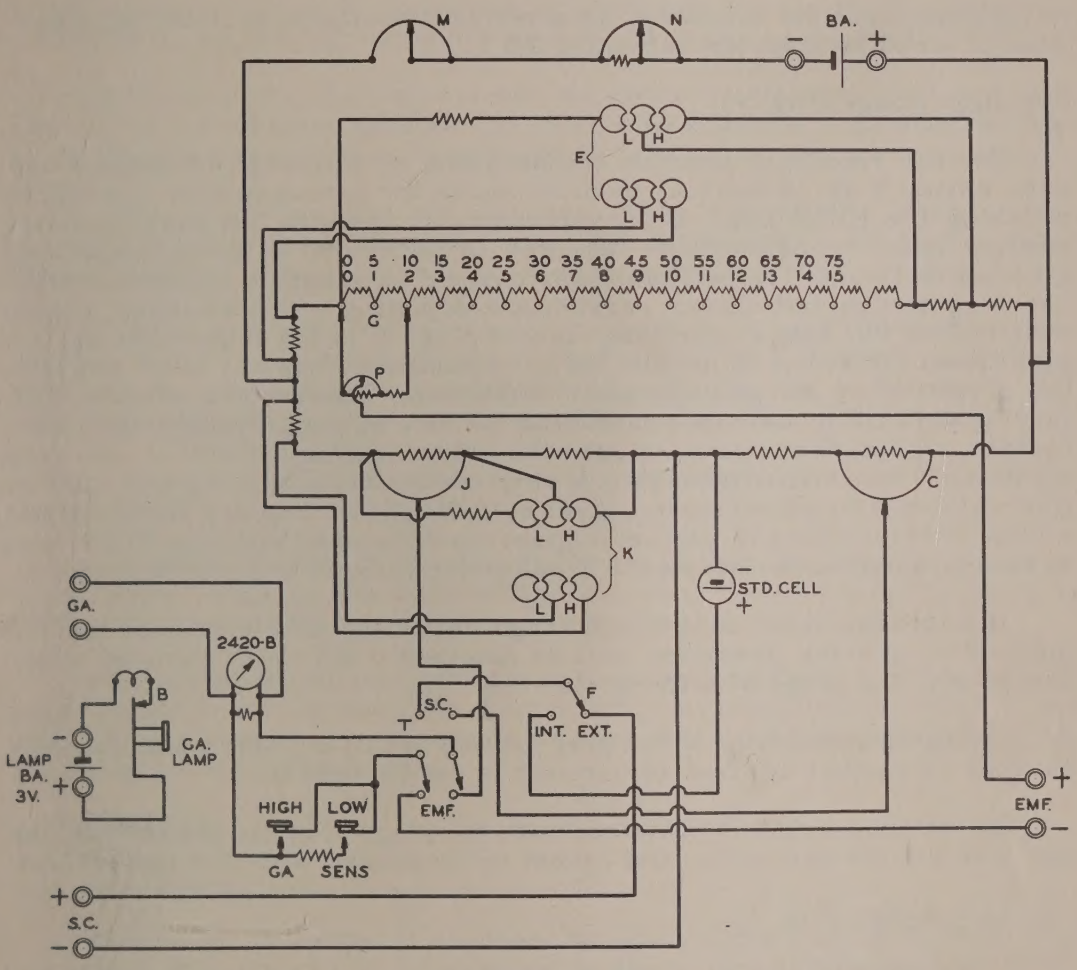

Fig. 4

Fig. 3 illustrated a case in which an iron-constantan thermocouple is used and the mercury thermometer shows a reference junction temperature of 80 F. The conversion tables for this type of couple show an emf of 2.30 millivolts at 80 F. Therefore, insert the plugs K in the H position and set dial J to read 2.30 on the red numbered scale under the index. This operation provides compensation for the reference junction temperature. Emf readings obtained as directed in Section 8 are then based on I.C. conversion tables for reference junction temperature of 0 F and no computing is necessary.

7. MEASURE EMF

If the estimated value of the emf to be measured exceeds 16 millivolts

or the emf cannot be estimated, proceed as directed in Section 7A, otherwise proceed as directed in Section 7B.

A. High Range (Fig. 1)

Set the reference junction compensator as directed in Section 6 and with switch T set in the S.C. position check the potentiometer current by pressing the HIGH key. If the galvanometer deflects, the potentiometer current must be adjusted as directed in Section 5. If the galvanometer gives no deflection the potentiometer current is properly adjusted. After checking the potentiometer current and adjusting it if necessary, return switch T to the E.M.F. position. Insert plugs E in the H position and set dial G and slidewire P, each to its zero position. Tap key LOW and note the direction of the galvanometer deflection. Slowly turn slidewire P, tapping key LOW at intervals, and if no balance of the galvanometer is indicated, set dial G at intervals until the galvanometer deflection reverses direction. Then turn slidewire P slowly toward zero, tapping key LOW at intervals until the galvanometer gives no deflection. Tap key HIGH, adjust slidewire P until the galvanometer gives no deflection with key HIGH open or closed, and read the emf on the H range (red) as directed in Section 8A.

If a measurement on the high range shows the emf to be less than 16 millivolts, greater precision will be obtained if the measurement is repeated with the plugs E in the L position.

Changing the position of the plugs E will not change the potentiometer current so another current adjustment is not necessary.

If a balance cannot be obtained with the plugs E in the H position, the emf exceeds 80 millivolts, and cannot be measured with this instrument.

B. Low Range (Fig. 1)

If the estimated value of the emf to be measured is less than 16 millivolts, place the plugs E in the L position and proceed otherwise as directed in Section 7A. Read the L range (black) as directed in Section 8B.

NOTE: When measuring temperatures lower than the reference junction temperature with this type of potentiometer (having manually operated reference junction compensator), the following procedure should be followed:

(1) Measure the temperature of the reference junction of the thermocouple by means of a mercury thermometer as directed in Section 6, measuring as closely as possible to the point where the compensating leadwires from the thermocouple join the copper circuit of the indicator, usually at the binding posts.

Look up the millivoltage corresponding to the measured reference

junction temperature in a conversion table suitable for the type thermocouple to be measured, using 0 F or 0 C reference as desired.

(2) Connect thermocouple leads to proper indicator posts but with polarity reversed from normal. In other words, connect the positive lead to the negative terminal and the negative lead to the positive terminal.

Set reference junction compensator to 0 millivolts. Make measurement of millivoltage in regular way, and algebraically add to this value the millivoltage of the reference junction temperature as determined in (1).

(3) With conversion table having temperature values below zero suitable for the thermocouple being measured and using 0 F or 0C reference, same as chosen for determination of reference junction millivolts in (1), read the temperature corresponding to the millivoltage determined in (2).

This will be the temperature of the measuring junction of the thermocouple.

CAUTION: Do not use reversed values from the table of temperatures above zero as the millivoltage values are not usually the same as for the corresponding temperatures below zero.

It is possible to obtain a special instrument, calibrated in degrees, to read below zero. In such an instrument, the conditions outlined in the NOTE above would not be true as a balance then could be obtained (within the range of the instrument).

8. READINGS

A. High Range (Fig. 1)

With plugs E in the H position the value of the emf being measured is equal to the sum of the red number on dial G opposite the index and the reading of the red numbered scale of slidewire P; for example, with dial G at 60 and slidewire P at 5, the reading of the instrument is 60 + 5 = 65 millivolts.

B. Low Range (Fig. 1)

With plugs E in the L position the value of the emf being measured is the sum of the white number on dial G opposite the index and the reading of the black numbered scale of slidewire P; for example, with dial G at 6 and slidewire P at .5 the reading of the instrument is 6 + .5 = 6.5 millivolts.

9. STANDARD CELL DATA

The voltage of the standard cell may be certified in either international (U.S.) or absolute units. If the certificate or tag furnished with the cell

does not indicate which system of units applies, consider the cell value as being given in international (U.S.) volts. When the standard cell dial is set to the voltage of the standard cell the instrument reading will be in terms of the unit system noted for the standard cell. If readings are desired in terms of the alternate unit system apply the conversion factor listed below to the certified cell voltage and set the standard cell dial to the calculated voltage value.

To convert from int (U.S.) volts to abs volts, multiply the int (U.S.) voltage by 1.000330.

To convert from abs volts to int (U.S.) volts, multiply the abs voltage by 0.999670.

Standard cell voltage. . . . . _____

Date measured. . . . . _____

Potentiometer serial number . . . . . _____

CAUTION: The standard cell in this instrument should never be used at temperatures below 32 F nor above 140 F. If it is necessary to use the instrument where the temperature is outside these limits, remove the standard cell, place it where the temperature will be within the limits and run temporary leads to terminals S.C. with polarities as indicated and throw switch F to the EXT. position.

10. TO CHECK STANDARD CELLS (Fig. 1)

To check other standard cells, use the standard cell contained in the potentiometer as a basis for comparison.

Adjust the potentiometer current as directed in Section 5, and leave switch T in the S.C. position. The positions of plugs E and K, dial switch G and slidewires P and J are immaterial in this check. Connect the standard cell to be checked, to the posts marked S.C. with polarities as indicated at the posts. Throw the standard cell switch F to position EXT. and balance the galvanometer by means of the standard cell compensating dial C. Then the reading of the standard cell compensating dial C is the emf of the external standard cell.

11. DRY CELLS

To replace the potentiometer circuit dry cell, remove the two screws from near the edge of the door on the right hand end of the instrument. Open the door, disconnect the old dry cell and remove it from the instrument. Put the new dry cell in place and connect it with polarity as stamped on the terminals of the dry cell leads. Close the door and secure it with the two screws.

To replace the lamp circuit dry cells, remove the two screws from near the edge of the door, on the right hand end of the instrument. Open the door, disconnect the old cells (two dry cells in series) and remove them from the instrument. Connect two dry cells in series and put them in the place from which the old ones were removed. Connect the two terminals to the cells. Polarity of the connections to these cells is immaterial. Close the door and secure it with the two screws.

A three volt source of alternating current or a three volt battery also may be used to supply the galvanometer lamp. Disconnect the galvanometer lamp dry cells located in the compartment in the right hand end of the instrument. Tape the terminals of the leads to prevent short circuit and connect the external cource of current to the LAMP BA 3V posts. Polarity of connections to the LAMP BA 3V posts is immaterial.

An external battery of 1-1/2 volts may be used for supplying the potentiometer current. Disconnect the dry cell in the compartment in the right hand end of the instrument, tape the terminals of the leads to prevent short circuit and connect the external battery to the BA posts, with polarity as indicated at the posts. For continuous service, several No. 6 dry cells connected in parallel will last longer.

12. CHECKING POTENTIOMETER RECORDERS, CONTROLLERS, AND INDICATORS

To check a recorder or controller having automatic reference junction compensation, proceed as follows:

Stop the recorder or controller (with the clutch released, in the case of some instruments); disconnect the thermocouple or thermocouples from the T.C. binding posts or connectors. Be sure that the pen, temperature index or print wheel is properly adjusted on its driving belt.

Connect the E.M.F. binding posts on the No. 8662 Potentiometer to the proper T.C. binding posts or connectors on the recorder or controller with any size insulated copper wire between No. 14 and No. 20 B&S gauge. Be sure the polarities are correct.

Adjust the No. 8662 galvanometer to zero as directed in Section 4 of these directions.

Adjust the current in the potentiometer circuit of both instruments, as directed in Section 5 of these directions, for the No. 8662 and as directed in the direction book for the recorder or controller.

Place the link across the GA posts on the No. 8662 in order to short circuit the galvanometer in this instrument and see that key T, Fig. 1, is in the E.M.F. position.

Obtain from "Standard Conversion Tables" (for the type thermocouple used with the recorder or controller) the millivolt value corresponding to the temperature of the reference junction compensator of the recorder or controller and set plugs K and dial J, Fig. 1, as directed in Section 6.

Set plugs E, dial G, and slidewire P, Fig. 1, to the millivolt value corresponding to the temperature at which it is desired to check the recorder or controller.

Start the recorder or controller. Depress key LOW and allow the recorder or controller to reach a balance. Then depress key HIGH and allow it to reach a balance. The pen, temperature index or print wheel should then register the temperature corresponding to the emf in millivolts at which the No. 8662 is set, within the combined adjustment accuracy of both instruments.

EXAMPLE: Make any preliminary adjustments as previously directed. Assuming that the recorder or controller is calibrated for iron-constantan thermocouple and that the temperature of the reference junction compensator is 80 F; refer to the "Standard Conversion Tables" for the corresponding millivolt value. This is found to be 2.30 millivolts. Then set the reference junction compensator plug switches and dial on the No. 8662, as directed in Section 6, of these directions. Assume 1580 F as the temperature at which it is desired to check the recorder or controller. The millivolt value for iron-constantan thermocouples at 1580 F, as obtained from the Conversion Tables, is 50.22. Set plugs E, dial G, and slidewire P, Fig. 1, to equal 50.22 millivolts. See that switch T, Fig. 1, is in the E.M.F. position. Start the recorder or controller. Depress key LOW and allow the recorder or controller to reach a balance. Then depress key HIGH and allow it to reach a balance. The pen, print wheel, or temperature index then should stand at 1580 F on its scale, within the combined adjustment accuracy of the two instruments.

If a recorder or controller having manual reference junction compensation is to be checked, the millivolt value corresponding to the reference junction temperature also must be set on the recorder or controller reference junction compensator.

When checking manually-operated potentiometer indicators, the same connections are used and the same procedure followed. However, the main dial of the indicator, which is being checked, must be turned manually until its galvanometer balances at zero. The reading on the main scale of the indicator being checked then should check with the main scale setting of the No. 8662, within the combined adjustment accuracy of both instruments.

NOTE: This is a check on the instrument only. If there is thermocouple trouble, the thermocouple should be replaced or further checks made to determine its error.

13. GALVANOMETER

An external galvanometer may be used instead of the galvanometer in the instrument. Withdraw the four screws which secure the top plate of the galvanometer compartment and remove this top plate. Disconnect the flexible leads of the galvanometer system from the clips, replace the top plate and secure it with the four screws. Connect the external galvanometer to the GA posts.

The galvanometer in the instrument may be used separately from the remainder of the potentiometer without disturbing internal leads. Connections should be made to the GA posts. When connections are made to the GA posts do not press the LOW or HIGH keys.

To remove the galvanometer, remove the top plate of the galvanometer compartment, as previously directed, and remove the knurled nut from the flange on the side of the galvanometer system. Disconnect the leads from the clips, lift the galvanometer system from the instrument.

ARMAMENT LABORATORIES
ELECTRONICS SECTION
ATT. OML-22

www.manualsplus.com
1031217